Titanium and Titanium Nitride Coatings produced by Gas Flow Sputtering

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Gas Flow Sputtering (GFS) belongs to the group of Physical Vapour Deposition techniques (PVD) like Electron Beam Physical Vapour Deposition and Magnetron Sputtering. The salient feature of GFS is the additional Argon gas flow that transports the sputtered material from the source to the substrate. Reactive deposition of nitrides or oxides can be achieved by injecting reactive gas from a second gas inlet into the gas stream. This prevents target poisoning and a constant high deposition rate can be achieved. In comparison to other PVD-techniques GFS operates in a high pressure regime between 0.3 and 0.7 mbar. Furthermore, the gas flow coats areas which are not in line-of-sight position without an additional substrate movement.

The goal of this work is to deposit stoichiometric titanium nitride (TiN) by GFS. TiN coatings show a high hardness that is suitable for wear protection applications. It can also be easily deposited by reactive gas flow sputtering. The influence of different process parameters on microstructure formation and composition of titanium and TiN coatings was investigated. Typical process parameters that were varied are bias voltage, substrate temperature and magnitude of nitrogen injection. Microstructure and composition of the deposited coatings were analysed by Scanning Electron Microscopy and by Energy Dispersive X-Ray Spectroscopy (EDX), respectively. The crystal structure of the coatings was examined by X-Ray Diffraction (XRD). In addition, micro hardness of the Ti and TiN coatings was tested, too.

The results showed that only a combination of a specific N_2 to Ar ratio and application of a bias voltage generated the typical golden coloured TiN coating. Deposition rates up to 10µm/h were observed. The magnitude of the bias voltage during coating the process caused in Ti and TiN coatings a striking change in microstructure. A fine columnar structure with open boundaries grew without bias support. This structure changed into a dense film by applying a bias voltage. Bias also supported formation of a uniform stoichiometric titanium nitride over the entire substrate surface. Normally, at the edges a ratio mismatch of Ti to N was found. The coatings showed a good adhesion in spite of bias application. The micro hardness of the coatings depended on process parameters and microstructure. The measured hardness values were in good agreement with the values from the literature.